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EXAMINER	
LANGMAN, JONATHAN C	

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1784	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/593,809	NARAYAN ET AL.	
	Examiner	Art Unit	
	JONATHAN C. LANGMAN	1784	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 December 2010*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *29-41* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *29-41* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

Claim 39 is objected to because of the following informalities: Claim 39 refers to diffuse rings and an x-ray scan of 30-35°, all of which are characteristic of the 'amorphous" tantalum, however, in line 3, applicant recites a "single crystal" microstructure. It appears that this is an inadvertent error, and the microstructure should be amended to be "amorphous". As in the previous rejection, claim 39 is examined as if it were teaching an amorphous microstructure.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 29-33, 38, and 40 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Regarding claims 29 and 38, applicant claims a tantalum film that has single crystal microstructure and no grain boundaries. The examiner can not find and the applicant has not shown support for a single crystal tantalum film with no grain

boundaries. The applicant defines "single crystal" at page 7, lines 1-7 of the originally filed specification. The applicant states "single crystal" refers to a tantalum film, characterized by an absence of large-angle crystal boundaries, and includes a material without large angle boundaries, wherein the term also includes enlarged crystals.

The applicant then described how to achieve these "single crystal" tantalum films, but never discloses a working example with single crystal films with no grain boundaries. Although applicant discloses on page 2, lines 23-36 that "single crystal alpha-Ta layers remain stable with temperature due to absence of grain boundaries and its high melting point...". This teaching of a single crystal film is in the background section of the specification, and does not show support for the instant Ta films to have no grain boundaries.

Claims 30-33, and 40 are rejected for being dependent upon base rejected claims.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 34-37, 39, and 41 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Ding et al. (US 6,057,237).

Ding et al. teach a silicon substrate (col. 1, lines 18-22), upon which is deposited a silicon oxide dielectric. Within a trench opening in the dielectric, alternating layers of amorphous tantalum and amorphous tantalum nitride are formed (col. 2, lines 30-45). The tantalum nitride can be formed as the first layer followed by a tantalum thereon (col. 2, lines 50-53). The deposition results in a wholly amorphous multilayer stack of alternating layers of TaN and Ta (col. 3, lines 4). A copper layer is formed thereon and the amorphous barrier layer prevents diffusion of copper into an adjacent dielectric material (col. 1, lines 54-61 and col. 3, lines 4-10). A dense, wholly amorphous layer, will inherently have no grain boundaries.

Ding et al. are silent to a diffuse ring in the electron diffusion pattern as well as a diffuse x-ray diffraction peak at two theta = 30-35°, however these characteristics are inherent to amorphous tantalum films. Where the claimed and prior art products are produced by identical or substantially identical processes, the Patent and Trademark Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 U.S.C. § 102, or "prima facie obviousness" under 35 U.S.C. § 103, jointly or alternatively, the burden of proof is the same, and its fairness is evidenced by the inability of the Patent and Trademark Office to manufacture products or obtain and compare prior art products. *In re Best,* 562 F.2d 1252, 1255 (CCPA 1977).

The mere recitation of a newly discovered property, inherently possessed by things in the prior art, does not cause a claim drawn to those things to distinguish over the prior art. In re Swinehart, 439 F.2d 210, 212-13 (CCPA 1971).

Since Ding et al. teaches the same amorphous tantalum film as instantly claimed, it is expected that it will possess the same material characteristics, i.e. x-ray diffraction pattern and diffuse ring.

Regarding claims 36 and 37, Ding et al. are silent to the net diffusion characteristics of the annealed structure, however, if the structure of Ding were annealed at 650-750°C for one hour, the film would inherently possess a net diffusion distance of less than 10 nms, as instantly claimed, as it has been held that similar materials will yield similar results (see in re best case law applied above).

Regarding claims 35 and 37, Ding et al. are silent to the resistivity of the tantalum, film, however, the discrete layer of amorphous tantalum, is expected to have the same resistivity instantly claimed (i.e. 250-275 micro ohm-cm), as a material and its properties are inseparable (see in re best case law applied above).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 38 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stavrev et al. (“Behavior of thin Ta-Based films in the Copper/barrier/Si system) in view of Menzel et al. (US 4,372,989).

Stavrev et al. teach methods of making an ideal diffusion barrier system between copper and silicon. Stavrev et al. teach that the barrier performance realies upon the grain boundaries, and teaches that nanocrystalline, amorphous, and single crystal tantalum films would provide the highest amount of barrier performance (see figure 2, and discussion on page 994). Stavrev et al. go on to teach methods of achieving amorphous and nanocrystalline tantalum films (Table 1, pg. 995, and abstract), but fail to teach a specific example employing single crystal tantalum films.

Menzel et al. teach forming monocrystalline tantalum films on silicon substrates (abstract and examples 1 and 2 (col's 4 and 5)).

It would have been obvious to use single crystal films of tantalum as taught by Menzel, as obvious alternatives to the disclosed amorphous and nanocrystalline films of Stavrev, as Stavrev teaches that these single crystal tantalum films will have similar barrier performances.

Although, Menzel does not teach that the single crystal tantalum film has a x-ray diffraction peak at two theta = 55° and characteristic (100) spot diffraction pattern and having no grain boundaries, these characteristics are all inherent to single crystal tantalum films, and are intrinsically present within the single crystal film of Menzel. (See in re best case law applied above).

Claim 40 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stavrev et al. (Behavior of thin Ta-Based films in the Copper/barrier/Si system) in view of

Menzel et al. (US 4,372,989), as applied to claim 38 above, in view of Woo et al. (US 6,531,780).

As described above, Stavrev modified by Menzel et al. teach a silicon substrate upon which is deposited a single crystal tantalum barrier layer, upon which is deposited a copper metallization. Stavrev and Menzel fail to teach forming a TiN or TaN layer in between the silicon substrate and the tantalum layer.

Woo et al. teach semiconductor devices comprising barrier layers of tantalum for copper metallizations (col. 4, lines 50-55, and col. 6, lines 7-15). Woo go on to teach that tantalum nitride and titanium nitride may be used as adhesion layers between the tantalum barrier layers and the silicon semiconductor substrate (col. 2, lines 58-60; col. 4, lines 25-40; and col. 6, lines 7-15).

It would have been obvious to insert tantalum nitride or titanium nitride between the tantalum layers and the silicon substrate of Stavrev modified by Menzel et al., as Woo et al. has shown that these nitride layers are known in the art to provide better adhesion for tantalum diffusion layers.

Claims 29-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Marcus ("Electrical and Structural Properties of Epitaxial bcc Tantalum Films") in view of Menzel et al. (US 4,372,989).

Regarding claims 29 and 30, Marcus et al. teach thin films of epitaxial single crystal films of tantalum formed on a substrate of cleaved MgO. The tantalum films are body centered cubic (bcc) and have a resistivity of 16 micro ohm–cm, indicative of alpha

phase tantalum (title, abstract and “introduction” section). Marcus teaches that electron diffraction patterns were obtained and only single crystal diffraction patterns were observed, thus the film is said to have characteristic (100) spot diffraction patterns, as instantly claimed (pg 3122, col. 2). Marcus goes on to teach that quenching from a high temperature results in a smooth single crystal film, with only dislocations present (i.e. no grain boundaries are present) (“summary” section, pg 3127).

Marcus is silent to the tantalum film being characterized by an X-ray diffraction peak at two theta = 55°. However this characteristic is inherent to the single crystal tantalum film of Marcus since it has been held that similar materials possess similar properties and characteristics. Where the claimed and prior art products are produced by identical or substantially identical processes, the Patent and Trademark Office can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of the claimed product. Whether the rejection is based on "inherency" under 35 U.S.C. § 102, or "prima facie obviousness" under 35 U.S.C. § 103, jointly or alternatively, the burden of proof is the same, and its fairness is evidenced by the inability of the Patent and Trademark Office to manufacture products or obtain and compare prior art products. *In re Best,* 562 F.2d 1252, 1255 (CCPA 1977).

The mere recitation of a newly discovered property, inherently possessed by things in the prior art, does not cause a claim drawn to those things to distinguish over the prior art. In re Swinehart, 439 F.2d 210, 212-13 (CCPA 1971). In the present case Marcus discloses single crystal tantalum films with the same resistivities, same diffraction characteristics, and same cubic structure; therefore it is the Examiner’s

position that the instantly claimed x-ray diffraction peak is present in the film of Marcus, since the film of Marcus has the same structure and the same characteristics as instantly claimed.

Marcus et al. teach the use of a cleaved MgO substrate, as well as that the cleavage technique is a modification of well known cleaved silicon substrates (pg 3122, col. 1, lines 1-3). Marcus et al. teach the use of their single crystal tantalum film in the semiconductor integrated circuit industry (pg 3121, col. 1). Marcus et al. fail to teach a silicon substrate.

Menzel et al. teach a single crystal tantalum film formed on a substrate (abstract). Menzel et al. teach that the use of these single crystal tantalum films are well known in the semiconductor integrated circuit industry (col. 1). Menzel et al. teach that the substrate may be ceramics or silicon substrates (col. 2, lines 30).

It would have been obvious to one of ordinary skill in the art at the time of the present invention to modify Marcus et al.'s substrate of cleaved MgO, to be a silicon substrate, as Menzel et al. have shown that silicon substrates are known substrates in the semiconductor industry for supporting single crystal tantalum films, and also are known alternatives to ceramic substrates, inclusive of the ceramic MgO substrate, taught by Marcus et al.

Regarding claims 31, as seen in Table 1, the room temperature resistivity is varied between 15 and 30 micro ohms-cm dependent upon the deposition temperature (Marcus et al. pg 3124).

Regarding claims 32 and 33, the applicant never positively recites that copper must be present in the film. The claim sets forth that the film has a net diffusion distance of less than 10 nms after annealing with copper at a temperature between 650-750°C for one hour. This limitation is an end effective result, where "if" the film is annealed it will possess these characteristics. Even though Marcus et al. do not teach this characteristic, it is expected that the instantly claimed characteristics of net diffusion will be present in the film of Marcus et al. when annealed with copper, since, as shown above, the films of Marcus et al. are the same as those presently claimed.

Response to Arguments

The 112 first paragraph rejection of claims 29 and 34, regarding support for a freestanding thin film, is withdrawn in light of applicant's amendments to the claims to include a substrate.

The 112 first paragraph rejection of claims 29 and 38 is maintained, as the applicant has not shown possession of the claim language of "no grain boundaries". The cited phraseology clearly signifies a "negative" or "exclusionary" limitation for which the applicants have no support in the original disclosure. Negative limitations in a claim which do not appear in the specification as filed introduce new concepts and violate the description requirement of 35 USC 112, first paragraph, *Ex Parte Grasselli, Suresh, and Miller*, 231 USPQ 393, 394 (Bd. Pat. App. and Inter. 1983); 783 F. 2d 453.

The insertion of the above phraseology as described above positively excludes grain boundaries, however, there is no support in the present specification for such

exclusions. While the present specification is silent with respect to grain boundaries within single crystal films (i.e. see applicants argument on page 6 of the remarks, that states that the "amorphous and single crystal tantalum films provide a far superior diffusion barrier than polycrystalline films containing grain boundaries. In other words the amorphous and single crystal tantalum films prepared and evaluated in the working examples of the Specification do NOT contain grain boundaries", it is noted that as stated in MPEP 2173.05(i), the "mere absence of a positive recitation is not the basis for an exclusion." The applicant has not shown where in the specification they positively exclude grain boundaries, and therefore the rejection under 112 1st paragraph over claims 29 and 38 is maintained.

The present specification teaches an absence of "large angle boundaries" (pg 7, col. 1-7). If the applicant were to amend claims 29 and 38 to include the emphasized language supported by the specification the 112 first paragraph rejection would be removed.

Marcus et al.

The 102b rejection over Marcus et al. is removed in light of the applicant's amendments to the claims. Marcus et al. teach the deposition on cleaved magnesium oxide substrates. Marcus et al. do not teach a silicon substrate.

Ding et al.

Applicant argues on page 7 of the remarks that contrary to the examiners position, Ding et al. do not teach amorphous tantalum films with no grain boundaries. Applicant relies on the teaching of Ding et al. col. 2, lines 54-62, which teaches that

tantalum films prepared therein are crystalline and the addition of tantalum nitride layers sandwiched between tantalum layers decreases crystallinity, and thus the applicant argues that Ding et al. describe a “less crystalline” tantalum layer.

The examiner respectfully disagrees. The whole disclosure of Ding et al. is to forming amorphous tantalum film and to avoid any crystallinity or grain boundaries. Ding et al. describe a dense amorphous tantalum layer (col. 2, lines 41). Ding et al. teach that a Tan layer formed thereon prevents grain boundaries from forming (col. 2, lines 46). And that the entire barrier layer is amorphous (col. 2, lines 47).

Although Ding et al. may describe one embodiment at col. 2, lines 54-62 that may have some presence of grain boundaries, “applicant must look to the whole reference for what it teaches. Applicant cannot merely rely on the examples and argue that the reference did not teach others.” In re Courtright, 377 F.2d 647, 153 USPQ 735,739 (CCPA 1967). As described above, the whole endeavor of Ding et al. is to “Wholly amorphous” (col. 3, lines 4), tantalum barrier layers, wherein grain boundaries are undesirable (col. 2 lines 35-40). Wholly amorphous, as described by Ding et al., reads on the claimed amorphous tantalum film.

Stavrev in view of Menzel

Applicant argues in the paragraph bridging pages 7-8 of the remarks, that "one of ordinary skill in the art would have no reason to apply the focused laser induced recrystallization employed to increase grain size in an already deposited film of Menzel, in the generic ideal study of Stavrev.

This arguments is a conclusory argument not supported by the record. Motivation for modifying Stavrev, can be found in Stavrev's teaching that single crystal barrier layers have a small defect density of free carriers, which is taught to be necessary for an efficient barrier film in the semiconductor industry (See at least Figure 2). Stavrev et al. teach that the deposition of single crystal tantalum barrier films requires too high of a temperature that would result in no practical applications in the semiconductor industry (col. 1, pg 994).

Menzel et al. teach this very same concept that high temperature anneals to obtain these single crystal microstructures in tantalum films are unfavorable (See col. 1, lines 35-40). Menzel et al. propose a new method of making single crystal tantalum films, which would not result in the undesired high temperatures. Therefore it is the examiner's position that one of ordinary skill in the art would have been motivated to use Menzel et al.'s teaching of low temperature formation of single crystal tantalum films, to modify Stavrev et al., as Stavrev teaches that single crystal tantalum films are desired in the art of diffusion barriers in the semiconductor industry, and Menzel et al. would overcome the deficiencies taught by Stavrev et al. to form a single crystal film at a temperature that is acceptable in the semiconductor industry.

New rejection Marcus et al. in view of Menzel et al.

Marcus et al. fails to teach a silicon substrate, and in light of the applicants amendment is withdrawn as rejection under 102b as described above. However, upon further consideration, and in light of the applicants amendment, Marcus et al. is

combined with Menzel et al., for Menzel et al.'s teaching of known substrates in the integrated circuits art including ceramics and silicon substrates

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JONATHAN C. LANGMAN whose telephone number is (571)272-4811. The examiner can normally be reached on Mon-Thurs 8:00 am - 6:30 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer McNeil can be reached on 571-272-1540. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JCL

/Timothy M. Speer/
Primary Examiner, Art Unit 1784